

Metabolism

Lecture 2

Basal Metabolic Rate “BMR” & Specific dynamic Action “SDA”

ILOs

By the end of this lecture the student will be able to:

- ❖ Define basal metabolic rate (BMR)
- ❖ List the basal conditions for the BMR
- ❖ Explain the physiological factors affecting the BMR
- ❖ List the pathological factors affecting the BMR
- ❖ Explain specific dynamic action (SDA) regarding (definition, its values for different food stuffs and the factors affecting it)

Basal metabolic rate “BMR”

Def.: It is the rate of energy production / h /square meter surface area under basal conditions “1, 2, 3 & 4”

- 1- Complete physical rest.
- 2- Complete mental rest.
- 3- Comfortable room temp.
- 4- Post - absorptive state.

- 1- Complete physical rest: - The person should be at physical rest for at least 30 min. before the test to avoid muscle exertion on heat production.

- 2- Complete mental rest: - To prevent a rise in epinephrine sec. & ↑ MR.
- 3- Comfortable room temp.: - To avoid shivering which ↑ heat production.
- 4- Post – absorptive state: - No food intake for about 12-14 h. before the test to avoid diet –induced thermogenesis.

Clinically, the BMR is usually expressed as a percentage increase or decrease above or below a standard normal values for that age and sex.

In a normal adult male, BMR is about 40 Cal/h/m².

If his BMR is 60 Cal/h/m², it is expressed as “+50 %”.

Factors that affect BMR

1- Physiological factors. **2-** Pathological factors. **3-** Chemical factors.

Physiological factors:

*** Age:**

Newborn = 25 C/H/M²

Age 2-5 years = 60 C/H/M²

Age 20 years = 40 C/H/M² (adult level).

Above 20 years → Decreased 1 C /10 years. ???.

***Sex:**

BMR is lower in female than in males by about 7 % due to more fat store in female with little metabolic activity, Less muscle bulk & Lack of male sex hormone.

*** Race:**

Orientals and Africans have lower BMR than Europeans.

*** Climate:**

= BMR is higher 10 % in individuals in cold climates.

= BMR lower in individuals in tropical (hot) countries.

*** Sleep:**

= Lower BMR by 10-15% due to:

a- Decreased skeletal muscle tone.

b- Decreased activity of Sympathetic Nervous System (SNS).

*** Physical habits:**

= The maximum metabolic rate reached during exercise is often said to be 10 times the BMR due to:

* More muscle bulk.
stores.

* Lesser amount of fat

N.B.: Trained athletes can increase their metabolic rate as much as 20-fold

*** *Dietetic habits:***

= Prolonged ingestion of protein-----> increases BMR more than eating CHO or mixed diet.

*** *Anxiety & stress:***

= Higher BMR, due to increase the level of stress hormone adrenaline, noradrenaline & cortisone.

2. Pathological factors:

A- Higher BMR in:-

* Hyperthyroidism up to 100 % or more.

* Hyperpituitarism: due to

- G.H. - TSH - ACTH

* Hypoparathyroidism: due to increased muscle tone.

* Hyperadrenalism: due to more secretion of catecholamine.

* Hyperpyrexia: Higher BMR by 10-14% for each 1°C rise in body temperature.

* Heart failure: Higher BMR due to increase activity of respiratory muscles.

* Diabetes insipidus: Higher BMR to maintain body temperature. (Excess water loss & water intake).

* Some blood diseases e.g. Leukemia. Also, in polycythemia due to overactivity of the bone marrow.

B- Lower BMR in:-

- * Hypothyroidism.
- * Hypopituitarism.
- * Hypo function of adrenal cortex.
- * Hypothermia: Decreased BMR 10 % for each 1°C lower.
- * Prolonged starvation decreases the BMR up to 40 % due to:
 - Depression of SNS.
 - Decreased catecholamines.
 - Decreased thyroxine and corticoids.
- * Certain diseases (e.g. Shock & nephrotic syndrome).

3. Chemical factors:

- * Hormones such as thyroid h., Adrenaline, ACTH & cortisone, G.H. & Male sex hormone → ↑ BMR.
- * Caffeine → ↑ BMR
- * Alcohol → ↑ BMR by ↑ heat loss due to cutaneous V.D. so, ↑ BMR to maintain body temperature.
- * Amphetamine → ↑ BMR, used in treatment of obesity.

Specific Dynamic Action (SDA)

Def.: The SDA of a food is the obligatory energy expenditure that occurs during its assimilation into the body.

- Start: - 1 hour after food ingestion.
- Maximum: - within 4-5 hours.
- Lasts: \approx 12-14 hours.

SDA of different food stuff:-

- ❖ CHO \rightarrow 6%
- ❖ Fat \rightarrow 4%
- ❖ Protein \rightarrow 30%
- ❖ Mixed diet \rightarrow 10%

It takes:

30 kcal to assimilate the amount of protein sufficient to raise the metabolic rate 100 kcal;

6 kcal to assimilate a similar amount of carbohydrate; and

5 kcal to assimilate a similar amount of fat.

The cause of the SDA, which may last for many hours, is uncertain.

Factors affecting SDA:

1- Type of food: - High protein diet has higher SDA.

2- Amount of food: - SDA is directly proportionated to the amount of food.

N.B.:

- The heat produced as a result of SDA is above that produced by BMR & work.
- It is derived from energy stores. So, ?????
- Prolonged protein ingestion would lead to loss of body weight.

3- External temp.: The excess heat produced as a result of SDA is completely lost from the body at 33 degree centigrade.

If temp. ↓, SDA retained in the body, to maintain body temp nearly constant, as in cold weather.

SUGGESTED TEXTBOOKS



1. Ganong's "Review of Medical Physiology", 25th edition, chapter 72, pages 459-467
2. Guyton and Hall "Textbook of Medical Physiology", 12th edition, chapter 72, pages 863-865
3. Sembulingam "Essentials of Medical Physiology", 6th edition, chapter 124 page 710 & see also pages " 94, 360-363, 391, 398,441, 464 & 501"

